Australian Government
Department of Defence
Defence Science and
Technology Organisation

The Scenario Analysis Tool Suite: A User's Guide

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DSTO–GD–0560

ABSTRACT

This document is a user guide for the software product, the Scenario Analysis Tool Suite (version 1.5). The tool suite implements several scenario analysis techniques, Morphological analysis, Field Anomaly Relaxation analysis, Battelle approach, Bayesian approach, as well as an extended approach of combining methods. Thus the tool provides the opportunity to compare these techniques using a specific strategic question and provides computer support for the new combined technique.

Published by

Joint Operations Division
DSTO Defence Science and Technology Organisation
Fairbairn Business Park,
Department of Defence, Canberra, ACT 2600.

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AR No. AR 014–360
January 2009

APPROVED FOR PUBLIC RELEASE

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1 Introduction

The Scenario Analysis Tool Suite (version 1.5) which is comprised of both the Morphological Analysis Tool and the Combined Approach Tool, has been created as a practical companion to the report on Scenario Analysis Methods in Defence Strategic Planning [6]. The report itself compares several techniques used in scenario analysis and identifies their usefulness and limitations.

Noticeably, non-Bayesian method (e.g. Morphological Analysis (MA) [17], Battelle approach [16], Field Anomaly Relaxation (FAR) [1, 2, 8, 9, 10]) does not consider the probabilities of influencing factors on the problem investigated, therefore, the selected scenarios may have very small probabilities and could not practically be a basis of a meaningful planning effort. While the Bayesian method (e.g. Cross-Impact Analysis using System of Equations [11, 12], or Goal Programming (GP) [3]) requires marginal and conditional probabilities for the pairs of factors as input. High demands are therefore placed on the expert's ability and willingness to make these estimates. Furthermore, the Bayesian method takes all scenarios into consideration. In consequence, the scenario probabilities are often very small.

The purpose of the strategic planning process is to reflect possible alternative developments which are constructed using quantitative data as well as the experience and intuition of experts and stakeholders. However, they are unlikely to be interested in the mathematical aspects of the scenario analysis. Hence the information required from them should be kept as simple as possible. A new technique which combines all the above methods in light of these requirements is created and the tool provides the opportunity to compare these techniques using a specific strategic question and provides computer support for this new technique.

Scenario development is a function carried out by many groups within Defence. Many of these groups have been supported by analysis from DSTO and other organisations and some have had associated software developed [7, 13, 15]. This tool differs from past work by incorporating various methods within a single program.

The Tool Suite is a software product which has the capability to conduct the following techniques: Morphological Analysis and Combined approach (thus including the Field Anomaly Relaxation, Battelle approach, Bayesian approach, and some extended methods: Cluster analysis, Integer Programming). Its aim is to remove the limitation on scenario development by the use of manual methods as described in Rhyne [10] which states that the vast number of configurations, makes removing an incompatible pair *'... a tedious, error-prone task when done by hand'*. The system will provide a means of implementing the manual steps, through the use of software and provide capture (by means of saving and allowing the user to go back) of the process so that it may be exported for scenario composition. The capture must be 'whole' in the sense that the system may be exported at any stage and continued manually.

The free, open-source integrated development environment (IDE) NetBeans [14] was used in the creation of Graphical User Interface (GUI) for the tool suite. External mathematical programming solver GLPK [5] and Statistical Package R [4] are the main engines for solving mathematical models and analysing results.

The tool was designed for use by people who have a knowledge of the methodologies being used. It is expected that they are familiar with the accompanying report [6]. It is not the intention to release this software into the Public Domain, but to provide it with support to DSTO colleagues or Defence staff who might need it.

The documentation also provides help on using the program with less potential trouble, by indicating which actions must be followed by **'must'**. Implementing these actions will ensure that the program will function as expected.

The tool was developed by Cigdem Dilek as part of her 'Industry Based Learning' year at DSTO. In her absence the primary points of contact for the work are Minh-Tuan Nguyen and Justin Beck both of Joint Operations Division.

2 Getting Started

2.1 Installation of the Scenario Analysis Tool Suite

To install the Scenario Analysis Tool Suite[1], follow the steps below:

1. Download a zip file[2] "ScenarioAnalysisToolSuite-v1.5.zip".
2. Unzip it to get the executable file "ScenarioAnalysisToolSuite-v1.5.exe"
3. Double-click the executable file to start the installation process. The screen shown in Figure 1 is the screen which the user will be prompted with.

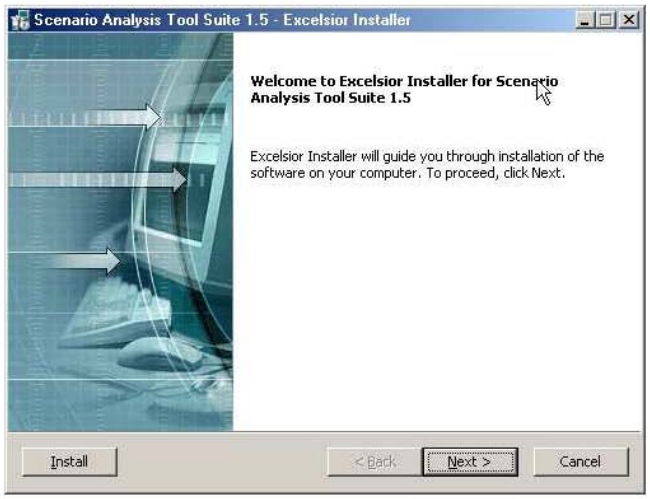


Figure 1: *Installation of the Scenario Analysis Tool Suite*

[1]This documentation refers to the installation of the version 1.5 of Scenario Analysis Tool Suite released on the 20-03-2008.

[2]The exact location of the file on the DSTO Community Portal can be obtained by contacting M.-T. Nguyen, minh-tuan.nguyen@dsto.defence.gov.au.

4. Clicking the Next > button and following the instructions detailed in the panels will install the software. It will then be available from the Start Menu in the directory which has been specified.

It should be noted that the two external tools, the mathematical programming solver GLPK [5] and the Statistical Package R [4] have been packaged into the above installation program.

2.2 Installation of Java Runtime Environment (JRE)

JRE 1.6 is used for running the Tool Suite, thus it is recommended that this version is installed on the machine on which the executable will be run on. Java JRE 1.6 can be downloaded from http://java.sun.com .

3 Exploring the Morphological Analysis Tool Environment

This section of the document aims to guide the user[3] through the Morphological Analysis Tool, referred to from now as the *MA Tool*. It supports a brainstorming process that ultimately produces amongst other things a matrix of pairs of factors[4] (also referred to as a morphological space in literature) thereby helping to explore a strategic question[5]. The tool and the documentation assume that the user using the tool is familiar with the morphological analysis method[6] [17].

The MA Tool is a standalone tool that can be used to perform a complete morphological analysis. It was designed with the intent that it would normally be used in combination with the Combined Analysis Tool that is described in Section 4 and 6 of this report.

3.1 Running MA Tool

To run the MA Tool:

1. From the Start Menu navigate to the directory in which the Scenario Analysis Tool Suite has been installed.

2. Click "Morphological Analysis Tool". This will run the tool and display the screen shown in Figure 2.

[3]The user has been identified as a decision maker in the field of strategic planning who is familiar with the morphological analysis technique and does not require familiarization with the technique.

[4]The MA Tool employs the terminology used in the Field Anomaly Relaxation method [10] by replacing the word component with sector and configuration with factor.

[5]The question being explored does not need to be one specific to strategy. The method allows exploration of any qualitative problem space.

[6]It is also presumed that the user is familiar with the terminology of the Field Anomaly Relaxation.

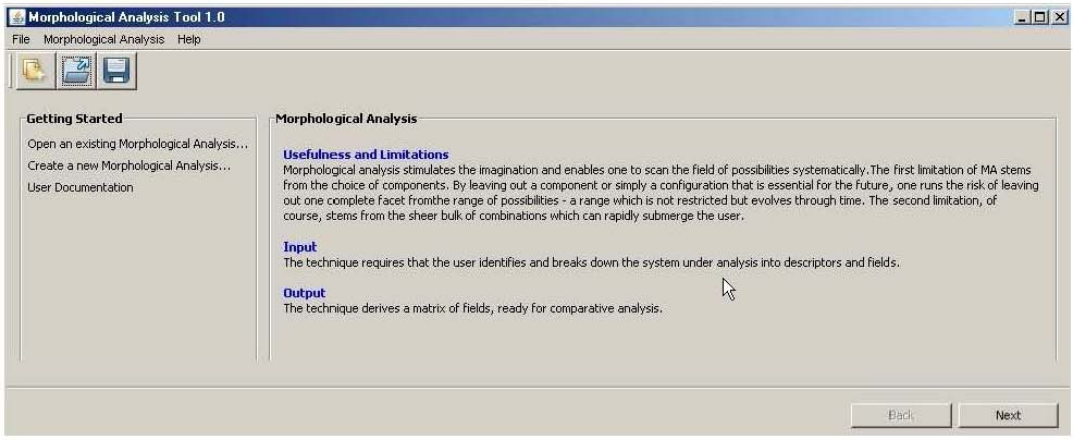


Figure 2: Morphological Analysis Tool Welcome Screen

3.2 Navigation

MA Tool interface as seen in Figure 2 allows the user to progress through the morphological analysis method by providing the use of Back and Next buttons located at the bottom right of each step (the welcome screen can be accessed from any stage of the method by choosing Help > Welcome screen). There are three steps in the morphological analysis:

1. brainstorming a question and then brainstorming the problem at hand into sectors then selecting those sectors that will be used in the analysis,
2. brainstorming factors for each sector and then selecting those factors that will be used in the analysis, and
3. creating a morphological space.

The user may also use the steps listed (Brainstorm Problem, Breakdown Components and Matrix of Pairs) under the menu item Morphological Analysis (located at the top of the tool) by clicking the required step.

3.3 User Help

The user may retrieve assistance in using the program by choosing
Help > User Documentation. This will open the user documentation for reference whilst using the tool. Or alternatively, click on User Documentation via the Welcome screen shown in Figure 2.

3.4 Basic Functionality

3.4.1 New Analysis

To create a new analysis:

1. Choose File > New Analysis
2. You will then be prompted to save the current analysis. Click Yes, to save the analysis and follow the steps in Section 3.4.2. Click No, to continue without saving the current analysis and this will take you to the first phase of the analysis. Clicking Cancel will dismiss the action and return to the previous state of the program.

Alternatively, click Create a new Morphological Analysis when on the Welcome screen. This action will also prompt to save and go through the same procedure described in Section 3.4.2.

3.4.2 Save Analysis

An analysis that has been completed can be saved for future use and an incomplete one can be saved so that it can be completed later. To save the current analysis:

1. Choose File > Save Analysis.
2. At the Save prompt, choose a directory and enter a file name for the analysis in the standard windows interface.
3. Click Save to continue saving the analysis, or click Cancel to return to the program.

3.4.3 Open a Morphological Analysis

A previously saved file can be loaded for reference, completion or to be modified. An example save file is include in the base directory of the default package and is called 'example.ma'. To open this or another existing morphological analysis:

1. Choose File > Open Morphological Analysis.
2. Select the file from the standard windows interface. By convention files that are able to be loaded should have the .ma extension.

3.4.4 Export Analysis

To export the current analysis: Choose File > Export Analysis. A readable form of the analysis will be available in the default directory indicated by the message box. The readable form can be opened in an internet browser program. It can then be printed from there.

3.4.5 Exit Program

To exit the program: Choose File > Exit. A prompt to save the current analysis will appear, and the same procedure described in Section 3.4.2 can be followed to guide through this process.

4 Exploring the Combined Approach Tool Environment

This section of the document aims to guide the user through the *Combined Approach* Tool. It supports the importation of a morphological analysis created with the *MA Tool*, and allows the user to step through the Battelle, Bayesian, Cluster Analysis and Integer Linear Programming techniques. The tool can be stopped and exported at any stage of the Combined Approach if only a portion of the techniques were of interest.

4.1 Running Combined Approach Tool

To run the Combined Approach Tool:

1. From the Start menu, navigate to the directory in which the Scenario Analysis Tool Suite is installed.
2. Click the Combined Approach Tool to run it. This action will display the screen shown in Figure 3.

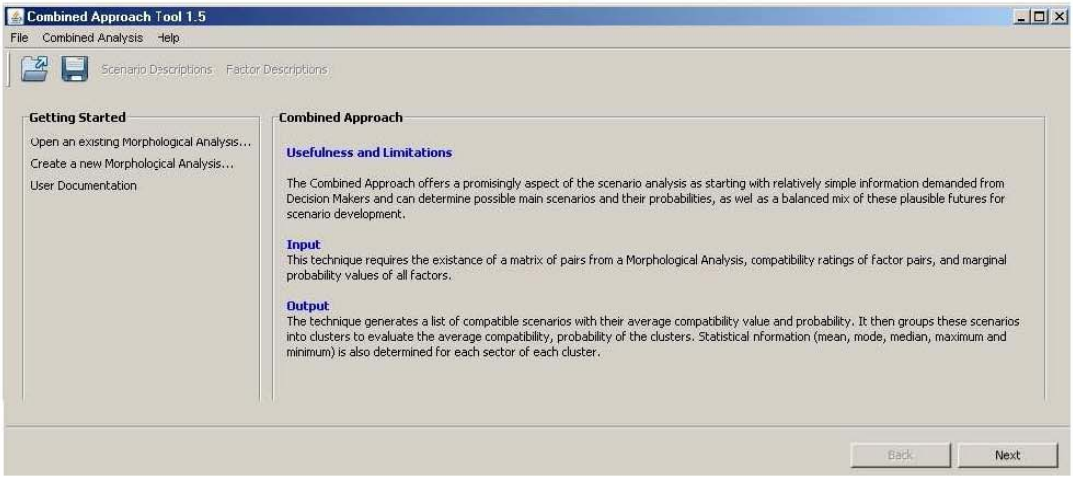


Figure 3: *Combined Approach Tool Welcome Screen*

4.2 Navigation

The Combined Approach Tool provides the same navigation functionality as the MA Tool; the use of Back and Next buttons located at the bottom right corner of the screen, or by selecting the desired panel from the Combined Analysis menu option located at the top of the program. The tool has been split into the following panels: Matrix of Pairs & Marginal Probabilities, Selected Compatible Scenarios, Scenario Probabilities, Cluster Analysis and Integer Linear Programming.

4.3 User Help

The user may retrieve assistance in using the program by choosing
Help > User Documentation. This will open the user documentation for reference whilst using the tool. Or alternatively, click on User Documentation via the Welcome screen shown in Figure 3.

4.4 Basic Functionality

4.4.1 Creating a New Combined Approach Analysis

A Combined Approach analysis requires the existence of a morphological analysis, thus a combined approach analysis cannot be created without first conducting a morphological analysis. To create a morphological analysis, see Section 5, or follow the steps in Section 4.4.3. If a morphological analysis already exists, steps in Section 4.4.2 can be followed to open the analysis. After which analysis can be saved as a Combined Approach analysis.

An example morphological analysis named 'example.ma' is provided with the tool and can be found in the base directory.

4.4.2 Opening a Morphological Analysis

To open a morphological analysis, implement the following steps:

1. Click File > Open Analysis. This will display a standard windows Open Dialog box.
2. Locate the directory in which the morphological analysis file is located.
3. Locate the analysis file with the .ma extension, and click on the filename. This will update the File Name input field with the name of the file.
4. Click the Open button.

4.4.3 Create a New Morphological Analysis

To create a new morphological analysis, either follow the steps in Section 5 or on the Welcome screen, click Create a new Morphological AnalysisĚ text on the left-hand Getting Started category. This will launch the MA Tool.

5 Creating a Morphological Analysis

5.1 Brainstorming a Question

The user may brainstorm a question and record this by entering the question into the text area adjacent to the question indicator in the Brainstorm Question step, as seen in

Figure 4. This may be revised later even if the user has progressed to later screens by using the back button.

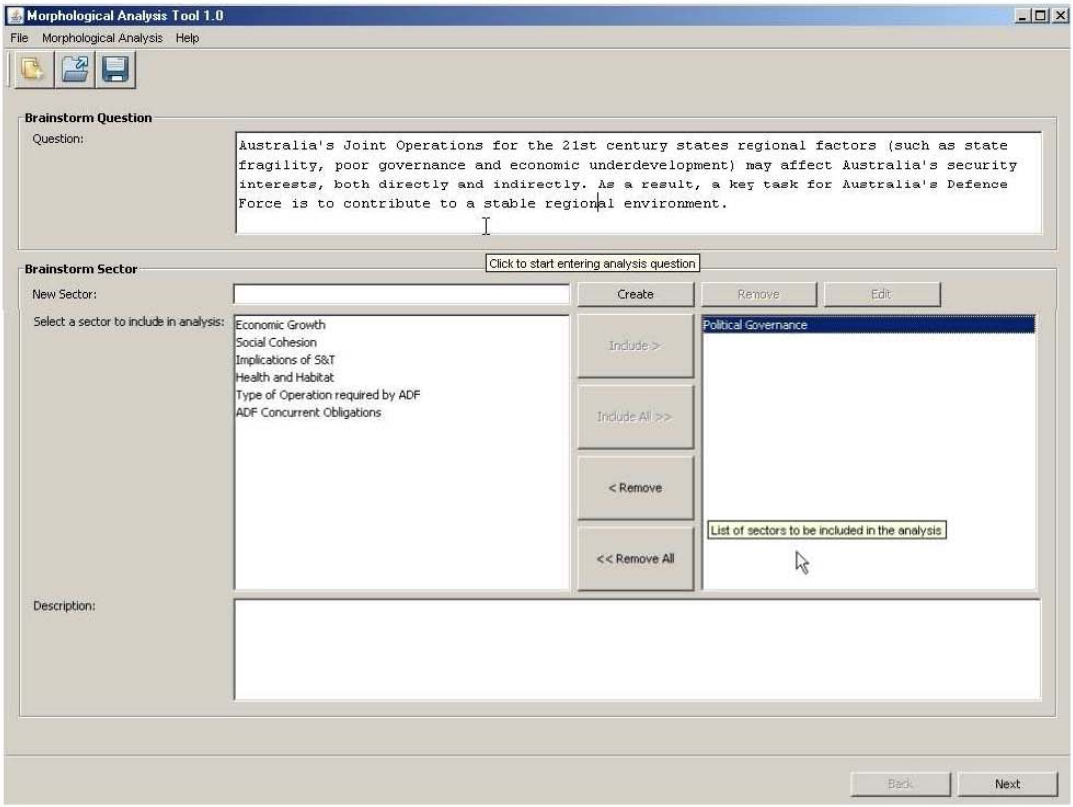


Figure 4: *Brainstorm Question & Selecting Sectors*

5.2 Sectors

The analysis technique requires that the problem be broken down into sub-systems or components, which are referred to as sectors. These sectors could be brainstormed using the tool, or entered into the tool after a 'white board' brainstorming session. Instructions in the next subsection refer to the sector screen shown in Figure 4.

5.2.1 Creating a New Sector

To create a new sector: Enter a sector name into the New Sector field and click the Create button adjacent to the field, as shown in Figure 4. This will add the newly created sector to the list of brainstorm sectors on the left hand side. Additional sectors are created by repeating this step.

5.2.2 Editing an Existing Sector

To edit the name of an existing sector:

1. Select the sector and click the Edit button. This will display the input dialog box.
2. Enter a new name into the input field and click the OK button. The changes will be reflected in the list.

5.2.3 Attaching a Description to the Sector

To record a description or details of the sector:

1. Select the sector in either list. This will enable input into the description input field.
2. Enter a description or details into the field. The text will be saved, when the cursor is moved to another input field.

5.2.4 Selecting a Sector to be Used in the Analysis

To include a sector in the analysis:

1. Select a sector from the brainstorm sector list, which will highlight the sector.
2. Click the Include> button. This will add the brainstorm sector to the selected list on the right hand side of the window. This step can be repeated for each desired sector.

5.2.5 Including all the Brainstormed Sectors in the Analysis

1. Click on any brainstorm sector. This will enable both the Include> and Include All>> buttons for use.
2. Click the Include All>> button. This will include all the sectors as selected sectors that will be used for further analysis.

5.2.6 Removing a Selected Sector from the Analysis

To remove a sector from the analysis:

1. Click on a sector in the selected list.
2. Click the Remove button. This will result in the sector being removed from the selected list and added to the brainstorm list. This step can be repeated to remove the desired sectors from the analysis.

5.2.7 Removing all Selected Sectors from the Analysis

To remove all the sectors from the analysis back to the brainstorm list:

1. Click on a sector in the selected sector. This will enable the <Remove and <<Remove All button.
2. Click the <<Remove All button to remove all the sectors from the selected list to the brainstorm list.

5.2.8 Removing an Existing Sector Permanently

To remove a sector:

1. Click on a sector in either the brainstorm list or the selected list. This will highlight the chosen sector
2. Click the Remove button. This action will result in the removal of the sector.

5.3 Factors

Many of the functions on the factors screen are identical to those on the sectors screen. This should aid the user to quickly become familiar with the tool.

5.3.1 Purpose of Screen

This screen allows the creation of factors for each sector. The factors describe possible states of the sector and should be entered in a sequential order. The screen itself is similar to the sectors screen. An example is shown in Figure 5.

5.3.2 Specifying a Letter Index for the Selected Sectors

A letter index for each sector is assigned initially by default[7] and displayed in the 'Current Letter' box. This may be changed by entering a New Letter. These letters will use as a *symbolic name* for the analysis.

1. If in the Brainstorm Question step, click the Next button to move to the Breakdown Components step (or wait until you naturally progress to this stage).
2. You **must** select a sector from the drop-down Select Sector box. Selecting the first sector Political Governance from the list (Figure 5), shows that the letter index assigned by default is P.

[7]By default the sector is assigned a letter index of the first letter of the sector name. If however, another sector of the same first letter already exists in either the brainstorm or selected list, then it is given a letter index of the same letter occurring multiple times.

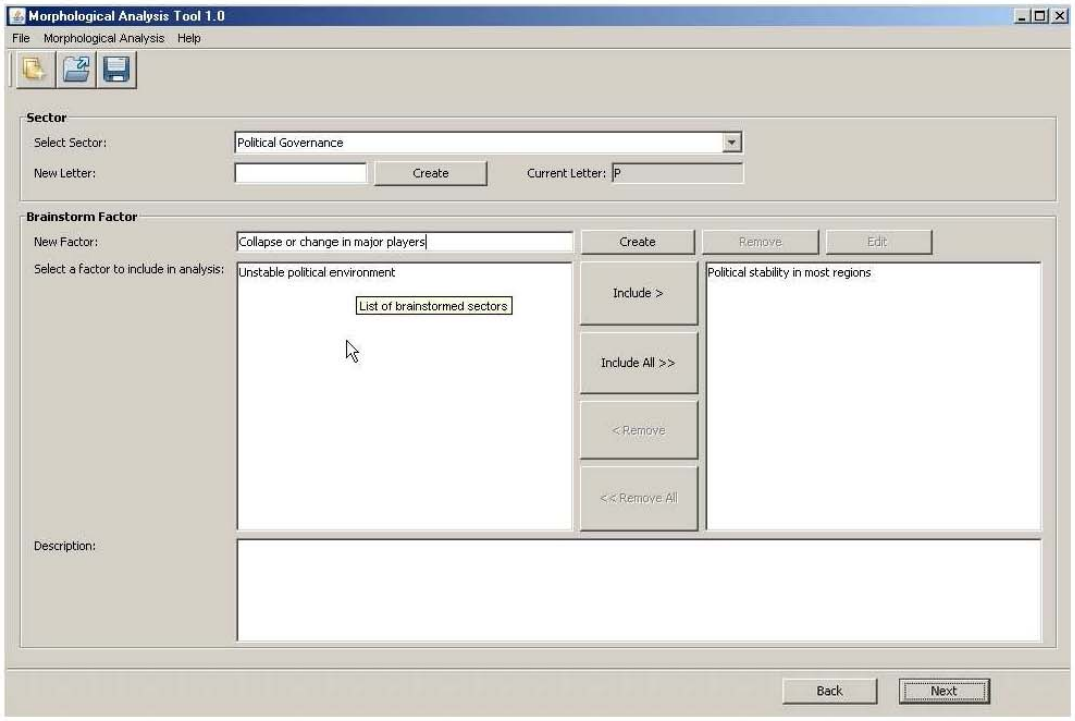


Figure 5: *Assigning Symbolic Name & Selecting Factors*

3. Another letter index can be specified by selecting the sector from the list and entering the new letter index into the New Letter input field and clicking the Create button adjacent to the field.

Note that when the screen is first displayed the current letter of the first sector is incorrectly displayed. Switching sectors corrects this.

5.3.3 Creating a New Factor

1. Select a sector from the sector list.
2. Enter the factor name into the New Factor input field and click the Create button adjacent to the input field. The newly created factor will be added to the brainstorm factor list as can be seen on the left-hand side of the panel shown in Figure 5.

5.3.4 Editing an Existing Factor

To edit the name of an existing factor from either the brainstorm or selected list:

1. Select the factor from the list. This will highlight the factor selected.
2. Click the Edit button, and this will display a dialog box which will prompt you to enter a New Factor name.

3. Enter a new name for the factor and click the OK button. This will change the name of the factor.

5.3.5 Selecting a Factor to be Used in the Analysis

In order for a factor to be used in the analysis, it must be moved from the brainstorm factor list to the selected factor list for the selected sector. A factor can be moved to the selected factor list by:

1. Selecting a factor from the Brainstorm Factor list, so it is highlighted.
2. Click the Include> button to remove the factor from the brainstorm factor list and add it to the selected factor list on the right hand side.

5.3.6 Attaching a Description to the Factor

A description or note can be attached to the factor to record the ideas which were discussed and present in the brainstorming session. This can be done by:

1. Selecting a factor by clicking on it, whether it is in the brainstorm factor list or the selected factor list. The selected factor will become highlighted, and enabled entry into the input field labelled as Description.
2. Enter a description into this field.
3. Selecting another factor or placing the cursor into another input field such as the New Factor field will automatically save the description. After which point, the description of a factor may be viewed (or edited) by selecting that factor.

5.3.7 Selecting all Brainstormed Factors to be Used in the Analysis

If all the factors in the brainstorm list need to be added to the selected list follow the steps:

1. Select any factor in the brainstorm list so that the Include All>> button can become active.
2. Once the Include All>> button is active, click on the button. This will then remove all brainstorm factors from the Brainstorm Factor list and add it to the selected factor list.

5.3.8 Removing a Selected Factor from the Analysis

To remove a single factor from the selected factor list and return it to the brainstorm factor list, follow the steps below:

1. Click on the factor to remove in the selected factor list. This will highlight the factor, and enable the <Remove button.
2. Click on the <Remove button.

5.3.9 Removing all Selected Factors from the Analysis

To remove all the selected factors from the selected factor list follow the steps below:

1. Click on any factor in the selected list. This will enabled the use of the <<Remove All button.
2. Click the <<Remove All button. This will remove all the selected factors from the selected list and add them to the brainstorm factor list so they may be added again if they are required. The tool allows the keeping a record of the factors that are not to be used in further analysis.

5.3.10 Removing an Existing Factor

A factor may be in either the brainstorm list or the selected list to be removed. It can be removed by:

1. Selecting the factor to be removed by clicking on it from the required list.
2. Click the Remove button adjacent to the Create button. This action will result in the complete removal of the factor from both lists of factors.

5.4 Matrix of Pairs

5.4.1 Viewing the Matrix of Pairs

A matrix may be viewed at any point. The matrix will display only those selected factors and sectors. In order to do this, follow the following steps:

1. Create sectors to be included in the analysis by creating a sector and moving it to the selected sector list.
2. To those sectors attach selected factors.
3. Click the Next button from the Breakdown Components panel to move to the Matrix of Pairs panel.

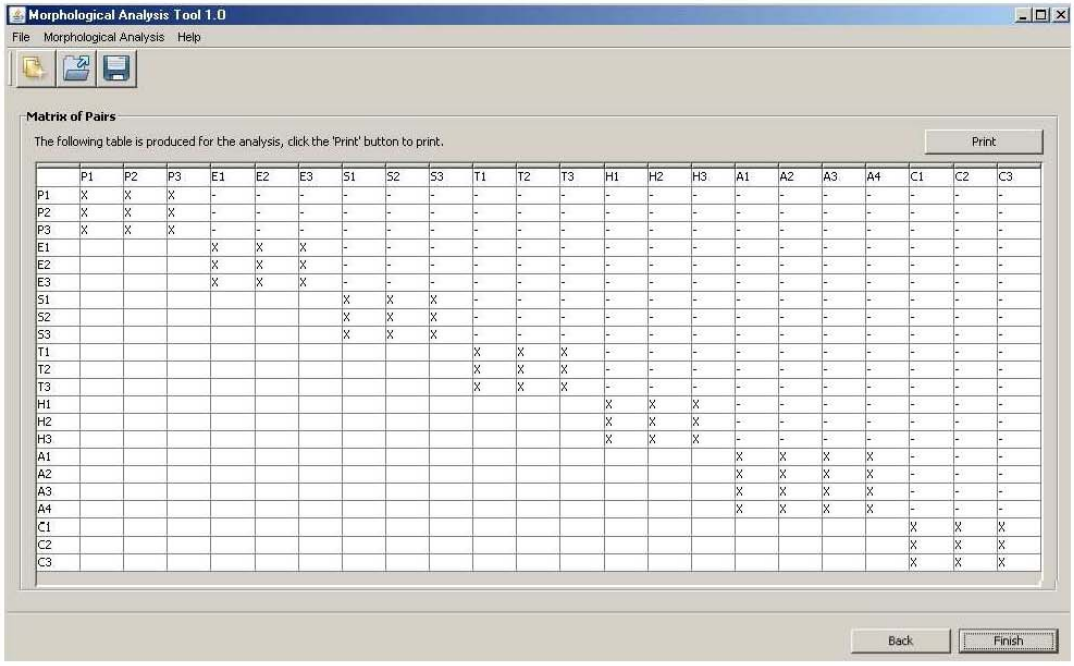


***Figure 6:** Matrix of Pairs*

The matrix of pairs can be seen as in Figure 6. All contain three factors with the exception of the second last sector 'A' which have four. A labelling system which represents both the sector and factor has been adopted. For example, E1 is the first selected factor of the sector with the letter index of E, thus each factor has both a row and column. A cell marked with an 'X' represents an incompatible comparison as they are factors of the same sector. A cell marked with a '-' (dash) represents a redundant comparison as filling in the bottom left-triangle of the table will result in making this comparison. The table cannot be edited but can be printed[8].

Filling in the table is done as part of the combined analysis in the associated tool.

5.4.2 Printing the Matrix of Pairs

To print a matrix of pairs:

1. Navigate to the Matrix of Pairs panel which is the last panel.
2. Click the Print button located at the top right-hand corner of the panel.
3. This will prompt you with a standard Print dialog box of Windows origin and select the required printer settings, and click the Print button. An example of a printout version can be seen in Figure 7, which is basically just the table seen in the Matrix of Pairs panel (see Figure 6).

[8]It is assumed that the decision makers will require a copy of the matrix to go away and fill in compatibilities and incompatibilities which they think apply to the problem space.

	P1	P2	P3	E1	E2	E3	S1	S2	S3	T1	T2	T3	H1	H2	H3	A1	A2	A3	A4	C1	C2	C3
P1	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P2	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P3	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E1				X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E2				X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E3				X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S1							X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-
S2							X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-
S3							X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-
T1										X	X	X	-	-	-	-	-	-	-	-	-	-
T2										X	X	X	-	-	-	-	-	-	-	-	-	-
T3										X	X	X	-	-	-	-	-	-	-	-	-	-
H1													X	X	X	-	-	-	-	-	-	-
H2													X	X	X	-	-	-	-	-	-	-
H3													X	X	X	-	-	-	-	-	-	-
A1																X	X	X	X	-	-	-
A2																X	X	X	X	-	-	-
A3																X	X	X	X	-	-	-
A4																X	X	X	X	-	-	-
C1																				X	X	X
C2																				X	X	X
C3																				X	X	X

Figure 7: *Print-out of the Matrix of Pairs Table*

P Political Governance	E Economic Growth	S Social Cohesion	T Implications of S&T	H Health and Habitat	A Type of Operation required by ADF	C ADF Concurrent Obligations
P1 Political stability in most regions	E1 Developing	S1 Tolerance between groups	T1 Conflict and uprising between group	H1 Improving/Sustainable	A1 Peacekeeping/Peace enforcement ADF role	C1 Minor commitment to regional Operations
P2 Unstable political environment	E2 Declining	S2 Factionalisation between groups	T2 Continuing (comparable) advancement of technology	H2 Degradation	A2 Counter Insurgency/Counter Terrorism	C2 Major commitment to regional Operations
P3 Collapse or change in major players	E3 Collapse	S3 Conflict and uprising between group	T3 Lagging advancement of technology	H3 Collapse, meltdown	A3 Conventional warfare	C3 Commitment to Operations further afield
					A4 Humanitarian assistance	

Figure 8: *Summary of Sectors/Factors*

The sectors and factors with their description can also be printed by choosing File > Export Analysis in the menu. Figure 8 is the summary table of sectors/factors extracted from the Export Analysis printout.

6 Using Combined Approach

When a morphological analysis is loaded into the combined approach tool the information it contains is displayed as in Figure 9. This section of the report guides the user through the functionality of the combined approach tool.

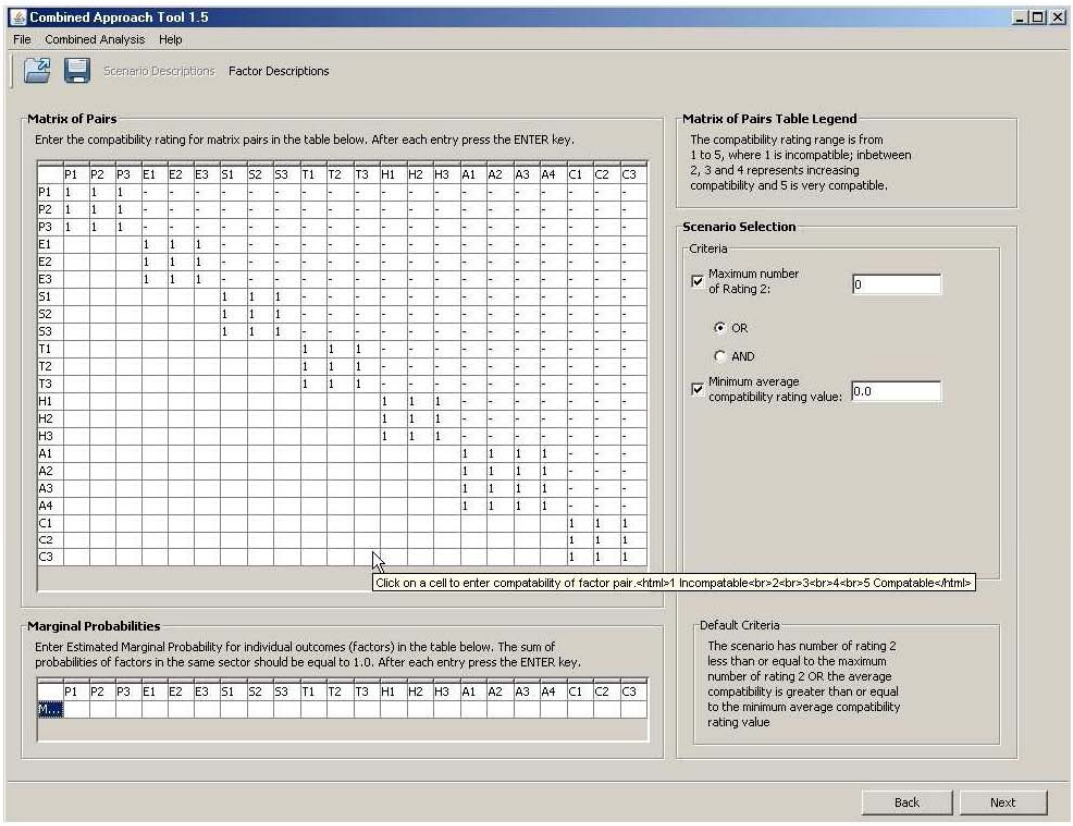


Figure 9: *Matrix of Pairs & Marginal Probabilities Panel*

6.1 Initial Data Input

6.1.1 Entering a Compatibility Rating of a Pair of Factors

Once a morphological analysis is open and the Matrix of Pairs and Marginal Probabilities table have both been created as seen in Figure 9, the compatibility ratings of pairs of factors can be entered. To do this, click on a cell referenced by the two factors for which you would like to give the rating of and enter a value. An input value of 1 to 5 inclusive is accepted (refer to the Matrix of Pairs Table Legend). Once a value has been entered, the Enter key **must** be pressed.

Please note, the Matrix of Pairs will populate the table with an incompatibility of '1' where the factors belong to the same sector. A '-' will be assigned to redundant cells.

Although all these cells should not be editable, the bottom left outer '1' values are. These values must not be changed and most have been disabled to prevent this from happening.

6.1.2 Entering a Marginal Probability for a Factor

The marginal probability of a factor can be entered by double-clicking the cell in the Marginal Probabilities table and entering a value. When a value has been entered the enter key must be pressed. The factors in the sector should sum to equal to or less than 1. A warning message will be displayed if they sum to something greater than one.

6.1.3 Scenario Selection

The scenarios can be filtered by using a selection criteria based on the maximum number of rating 2 values and/or the minimum average compatibility rating value[9] allowed.

- *Entering a maximum number of rating 2 value:*

  The maximum number of rating 2 criteria works by disallowing scenarios that have more pair-wise rating 2 than this value. This value can be entered by entering an integer in the Maximum number of Rating 2 input field. After a value has been entered, the cursor **must** be placed in Minimum average compatibility rating value input field to register the rating 2 value criteria.

- *Entering a minimum average compatibility rating value:*

  The minimum average compatibility rating value works by selecting those scenarios which have an average compatibility rating of the value or higher. To enter a minimum average compatibility rating value, by entering a value in the minimum average compatibility rating input field. After the value has been entered, the cursor **must** be placed in the maximum number of rating 2 input field. The input field accepts real (decimal) numbers between 1 and 5 inclusive.

- *Specifying scenario selection filter technique*: the first or the second criteria can be applied, or both.

  To specify only the first criteria: Ensure that the maximum number of rating 2 criteria is checked and the minimum average compatibility rating is not, regardless of whether the Or or And button is selected.

  To specify only the second criteria: Ensure that the minimum average compatibility rating criteria is checked and the maximum number of rating 2 is not, regardless of whether the Or or And button is selected.

  To specify if either the first or the second criteria is met then the scenario should be included: Ensure that the minimum average compatibility rating criteria and the maximum number of rating 2 is checked, and select the Or button.

[9] The terminology of 'upper-bound value' and 'lower-bound value' are used for the maximum number of rating 2 values and the minimum average compatibility rating value respectively in the companion report [6, Section 6.2.3].

To specify that a scenario must meet the first and the second criteria: Ensure that the minimum average compatibility rating criteria and the maximum number of rating 2 is checked, and select the And button.

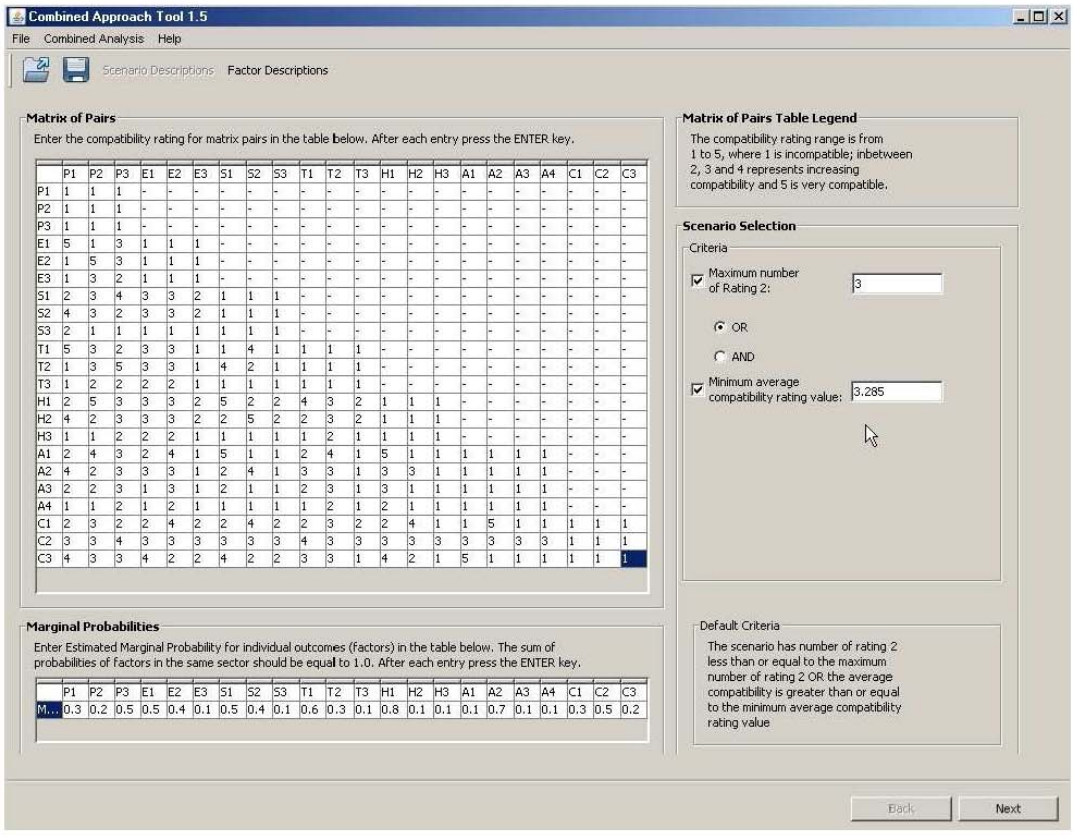
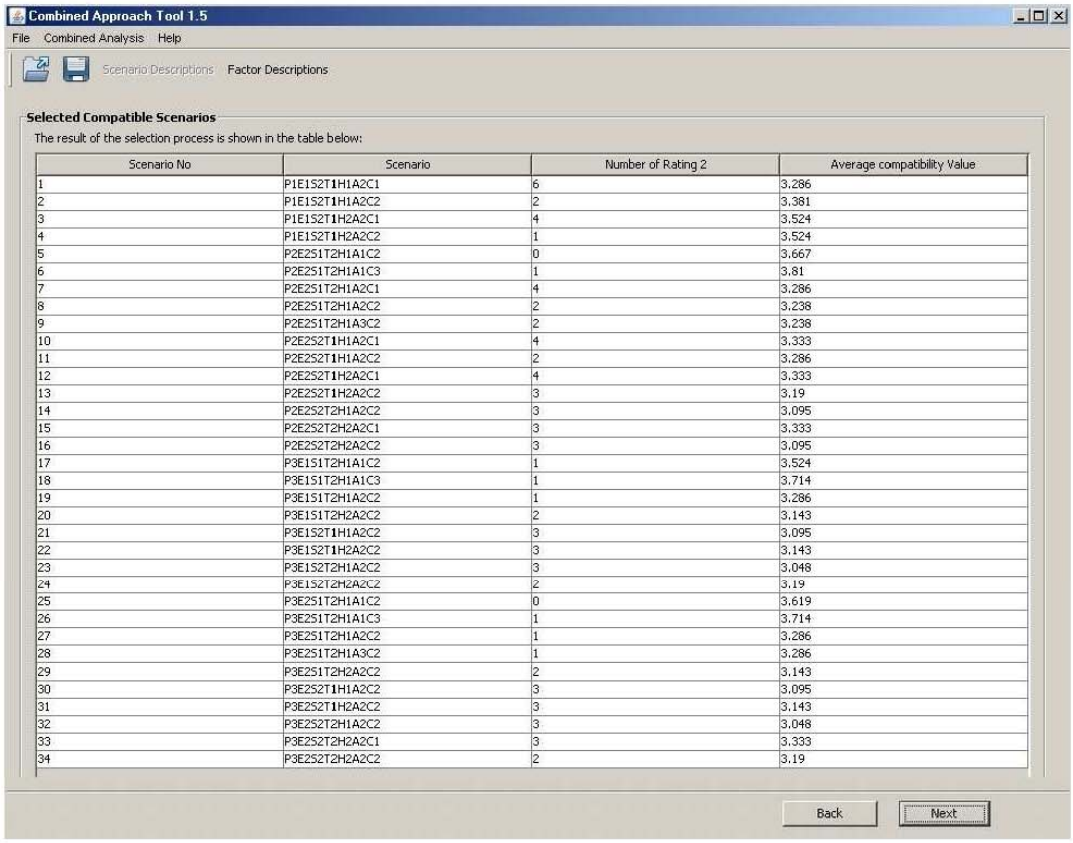


Figure 10: *Initial Data Input Complete*

6.2 Selecting Compatible Scenarios Using Battelle Approach

Once the initial input data has been entered (as in Figure 10), the Next button can be clicked to display the results of using the Battelle Approach (see Figure 11).



Scenario No	Scenario	Number of Rating 2	Average compatibility Value
1	P1E1S2T1H1A2C1	6	3.286
2	P1E1S2T1H1A2C2	2	3.381
3	P1E1S2T1H2A2C1	4	3.524
4	P1E1S2T1H2A2C2	1	3.524
5	P2E2S1T2H1A1C2	0	3.667
6	P2E2S1T2H1A1C3	1	3.81
7	P2E2S1T2H1A2C1	4	3.286
8	P2E2S1T2H1A2C2	2	3.238
9	P2E2S1T2H1A3C2	2	3.238
10	P2E2S2T1H1A2C1	4	3.333
11	P2E2S2T1H1A2C2	2	3.286
12	P2E2S2T1H2A2C1	4	3.333
13	P2E2S2T1H2A2C2	3	3.19
14	P2E2S2T2H1A2C2	3	3.095
15	P2E2S2T2H2A2C1	3	3.333
16	P2E2S2T2H2A2C2	3	3.095
17	P3E1S1T2H1A1C2	1	3.524
18	P3E1S1T2H1A1C3	1	3.714
19	P3E1S1T2H1A2C2	1	3.286
20	P3E1S1T2H2A2C2	2	3.143
21	P3E1S2T1H1A2C2	3	3.095
22	P3E1S2T1H2A2C2	3	3.143
23	P3E1S2T2H1A2C2	3	3.048
24	P3E1S2T2H2A2C2	2	3.19
25	P3E2S1T2H1A1C2	0	3.619
26	P3E2S1T2H1A1C3	1	3.714
27	P3E2S1T2H1A2C2	1	3.286
28	P3E2S1T2H1A3C2	1	3.286
29	P3E2S1T2H2A2C2	2	3.143
30	P3E2S2T1H1A2C2	3	3.095
31	P3E2S2T1H2A2C2	3	3.143
32	P3E2S2T2H1A2C2	3	3.048
33	P3E2S2T2H2A2C1	3	3.333
34	P3E2S2T2H2A2C2	2	3.19

Figure 11: *Results using Battelle Approach*

A table of scenarios remaining, their number of rating 2 value and average compatibility value are shown. The user at this stage may like to go back and review their input data or progress to the next stage.

6.3 Projecting Scenario Distribution Using Bayesian Approach

Figure 12: *Computation Time for Bayesian Approach*

Once the user has finalized the scenarios retrieved from conducting the Battelle Approach, the user can click the Next button to progress to the results of conducting the Bayesian Approach. A message prompt estimating how long the calculation will take is then display (Figure 12). When this has been acknowledged the calculations will start. The results are shown in a table, where each scenario has its configuration and its probability displayed.

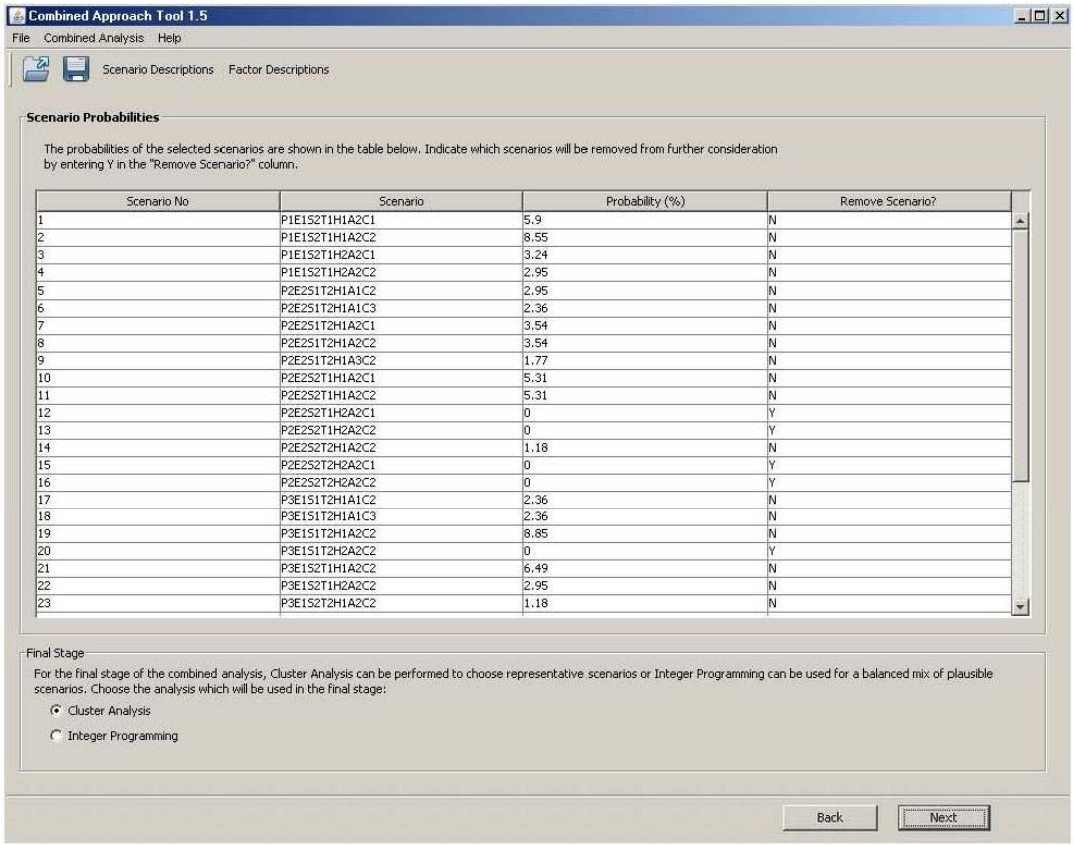


Figure 13: *Outputs from Conducting Bayesian Approach*

6.4 Confirming Selected Compatible Scenarios

By default, those scenarios which have a probability of zero have been set to be excluded from the next stage of the analysis.

- *To remove additional scenarios from the analysis:* enter a value of 'Y' in the Remove Scenario? column for the scenario which is to be removed.
- *To* ***not*** *remove a scenario from the analysis:* enter a value of 'N' in the Remove Scenario? column for the scenario which is not to be removed.

Once the scenarios to be removed or included have been specified, the user may either conduct a Cluster Analysis of the results, or Integer Linear Programming.

In order to conduct a Cluster Analysis, select the Cluster Analysis option in the Final Stage options. Otherwise, select the Integer Programming option. After the selection has been made, click the Next button to ensure that the appropriate screen is displayed.

6.5 Cluster Analysis

Assuming that the user has selected to conduct a cluster analysis as the final stage of the combined approach analysis, the screen displayed in Figure 14 will be shown. The figure shows that all the Show buttons corresponding to the number of clusters are enabled[10], this indicates that the group of selected scenarios could be grouped into up to five clusters. A Show button which is disabled indicates that the scenarios could not be grouped into the number of clusters for which it is disabled[11].

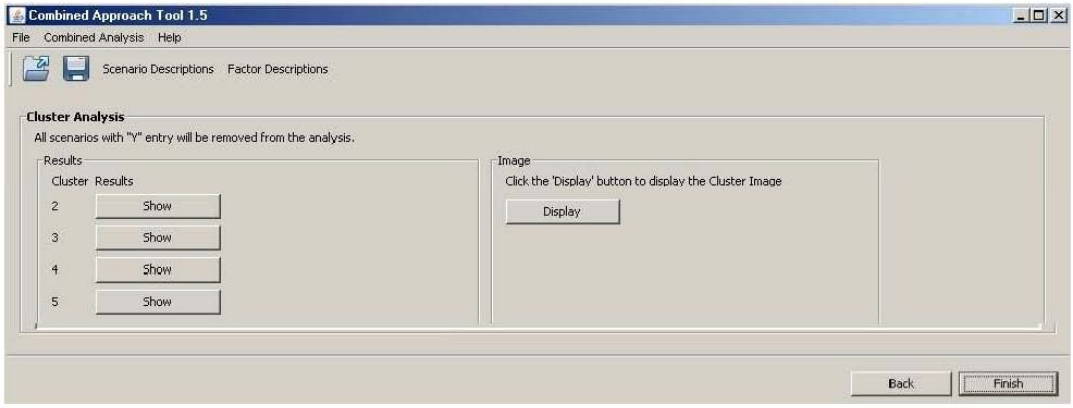


Figure 14: *Cluster Analysis Panel*

6.5.1 Viewing Cluster Information

To view the scenarios and their statistics as mentioned in the companion report [6]: click the Show button adjacent to the corresponding number of clusters of interest. This action will result in displaying another screen which shows statistical data corresponding to the grouping of scenarios into clusters (see Figure 15).

6.5.2 Viewing Cluster Image

To view the cluster image that has been generated by the Statistical R package: click the Display button on the right-panel. This action will display a separate window displaying

[10] means that clicking the button will execute a function.
[11] means that clicking the button will not make changes to the program or perform any function.

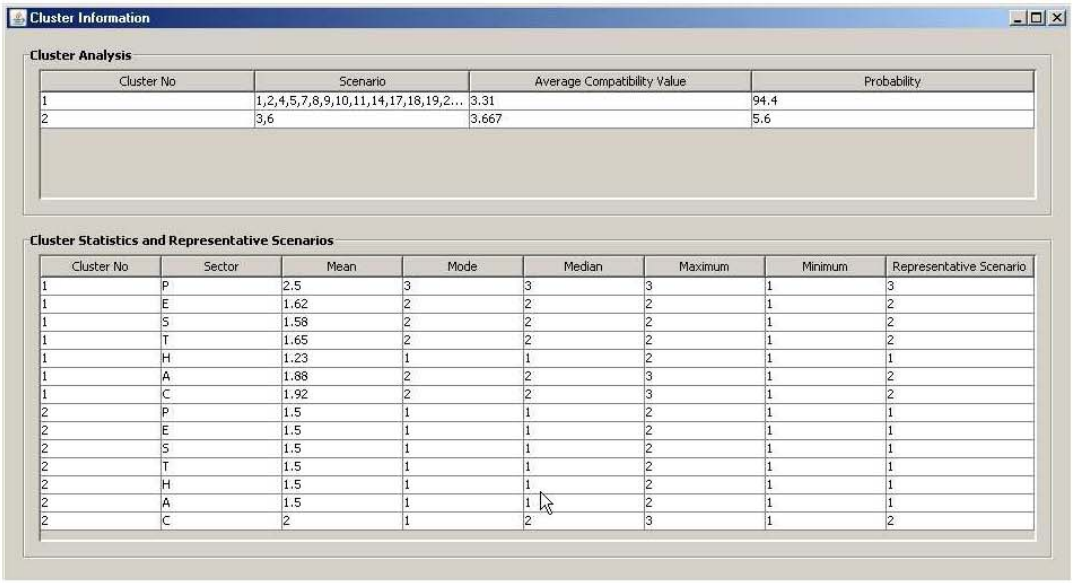


Figure 15: *Cluster Information*

the image. A file containing this image is generated as a bi-product of the analysis and can be found in the program directory.

6.6 Integer Programming

If the Integer Programming option (see Figure 13) of the Combined Approach analysis was selected then the panel show in Figure 16 will be displayed. It requires further input before the calculations can be made.

6.6.1 Specifying the Number of Factors in the Scenario Set

In order to find the smallest number of scenarios that cover the number of factors specified, implement the following steps: for the factor of interest, change the value in the column titled N by double clicking the cell and entering a new value.

6.6.2 Specifying the Probability of the Factors Occurring

The probability of the factor is specified as follows: for the factor of interest, change the value in the column labelled P. All factors in this column **must** to add up to a probability of equal to or less than 1. If this is not the case, the user will be notified.

6.6.3 Finding a Integer Programming Solution

In order to find a Integer Programming solution: click the Find (alternative) solution button located at the bottom-left of the panel. This action will display a separate panel.

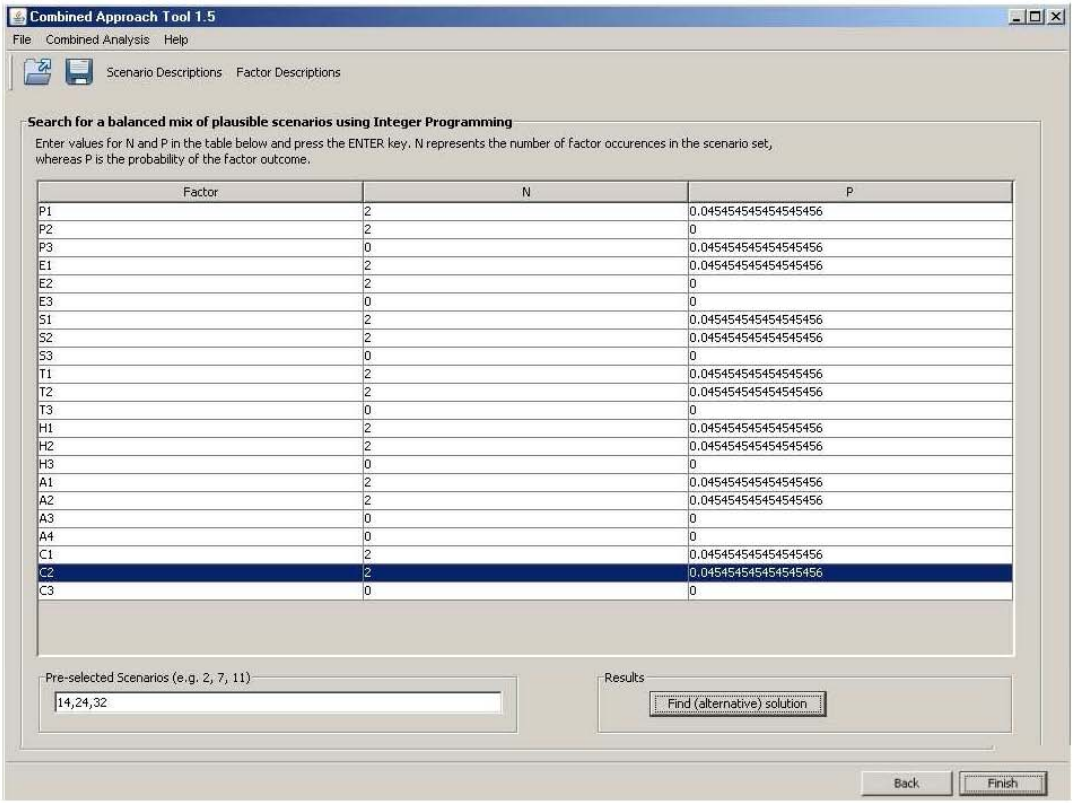


Figure 16: *Integer Programming Panel*

- If a feasible solution can be found, the scenario set and the values for N and P will be shown in a table.
- If however, there is no feasible solution, there will be no output displayed in the panel and the user will be prompted to re-enter input data in Figure 16.

7 Summary

This documment has described, in detail, how to use the *Morphological Analysis Tool* and the *Combined Approach Tool* that forms the *Scenario Analysis Tool Suite.*

As with any piece of software, there may be bugs remaining in the code. To date the program has not undergone extensive verification and validation due to a lack of available resources, in particular the end of the primary programmer's contract at DSTO.

Together with this user manual and the companion report on the scenario analysis methods, this tool provides an excellent resource for the conduct of strategic analysis. However, by itself the tool will not perform this analysis. Trained staff should still be used to interpret the inputs and the results of the model.

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DEFENCE SCIENCE AND TECHNOLOGY ORGANISATION DOCUMENT CONTROL DATA					1. CAVEAT/PRIVACY MARKING
2. TITLE **The Scenario Analysis Tool Suite: A User's Guide**					3. SECURITY CLASSIFICATION Document (U) Title (U) Abstract (U)
4. AUTHORS Cigdem Dilek					5. CORPORATE AUTHOR Defence Science and Technology Organisation Fairbairn Business Park, Department of Defence, Canberra, ACT 2600.
6a. DSTO NUMBER DSTO–GD–0560	6b. AR NUMBER AR 014–360		6c. TYPE OF REPORT General Document		7. DOCUMENT DATE January 2009
8. FILE NUMBER 2008/1041544/1	9. TASK NUMBER 07/064	10. SPONSOR Strategic Policy (Branch)	11. No OF PAGES 24		12. No OF REFS 17
13. URL OF ELECTRONIC VERSION http://www.dsto.defence.gov.au/corporate/reports/DSTO–GD–0560.pdf			14. RELEASE AUTHORITY Chief, Joint Operations Division		
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19. ABSTRACT This document is a user guide for the software product, the Scenario Analysis Tool Suite (version 1.5). The tool suite implements several scenario analysis techniques, Morphological analysis, Field Anomaly Relaxation analysis, Battelle approach, Bayesian approach, as well as an extended approach of combining methods. Thus the tool provides the opportunity to compare these techniques using a specific strategic question and provides computer support for the new combined technique.					